writing, and informs us that 1441 copybooks were sent in (as against 1121 in 1892). An eighth competition is announced for June 1894, when prizes to the amount of £60 will be awarded.

THE following is a complete list of the candidates to whom the University of London has awarded the degree of Doctor of Science this year:—Experimental Physics: Robert Wallace Stewart; Chemistry: Fredk. Daniel Chattaway and John Theodore Hewitt; Zoology: Henry Bargman Pollard; Animal Physiology: John William Pickering; Geology and Physical Geography: John Walter Gregory, William Fraser Hume, Maria Matilda Ogilvie.

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, Vol. ii. No. 10. July 1893 (New York: Macmillan).—This young mathematical society crowns the previous good work of its *Bulletin*, in this, the concluding number of its second volume, by the translation and publication of Dr. Felix Klein's "programme on entering the philosophical faculty, and the senate of the University of Erlangen in 1872." It is entitled "A comparative review of recent researches in geometry" (pp. 215–249). The author prefixes a note in which he states that the programme had a limited circulation at first, with which he was then fairly well satisfied, but now that Lie's "Theorie der Transformationsgruppen" has appeared, and that an Italian translation has been published in the *Annali di Matematica*, it seems proper that a wider circulation should be given to his expositions. The translation, which is a literal one, has been admirably done by Dr. M. W. Haskell, and we feel sure that its publication will greatly extend Dr. Klein's *clientèle*. A few additional footnotes are supplied here and there. Dr. F. N. Cole continues his previous work with an article on "the transitive substitution-groups of nine letters" (pp. 250–258). He points out that Mr. Askwith (*Quar. Jour. of Mathematics*, vol. xxvi.) gives only 22 of the 34 actually existing types, and discusses the complete list of the transitive groups of this degree, with brief explanations of the processes by which he has obtained them. Prof. Ziwet gives a brief analysis (pp. 258, 9) of the "Index du répertoire bibliographique du Sciences Mathématiques, publié par la Commission permanente du répertoire" (Paris, 1893). Notes, lists of new publications, and the index complete the number.

IN the *Botanical Gazette* for July, Mr. D. M. Mottier has a paper on the embryo-sac and embryo of *Senecio aureus*; his results agree closely with those of Strasburger on *S. vulgaris*; Mr. P. Dietel describes a number of new specimens of Uredineæ and Ustilagineæ; Mr. G. F. Atkinson completes his account of the biology of the organism which causes tubercles in the roots of Leguminosæ; and Mr. C. Robertson contributes another to his series of articles on flowers and insects.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 15.—"On the Annual and Semi-annual Seismic Periods." By Charles Davison, M.A., Mathematical Master at King Edward's High School, Birmingham. Communicated by Prof. J. H. Poynting, F.R.S.

Method of Investigation.—The method adopted is similar to that employed by Dr. C. G. Knott in his paper on "Earthquake Frequency."

If $f(\theta)$ be a periodic function of θ, then

$$f(\theta) = a_0 + a_1 \cos(\theta + \alpha_1) + a_2 \cos(2\theta + \alpha_2) + \dots a_n \cos(n\theta + \alpha_n) + \dots,$$

from which it follows that

$$\frac{1}{\pi}\int_{\theta-\pi/2}^{\theta+\pi/2} f(\theta)d\theta = a_0 + \frac{2a_1}{\pi}\cos(\theta + \alpha_1) - \frac{2a_3}{3\pi}\cos(3\theta + \alpha_3) + \dots + \frac{2a_n \sin\frac{n\pi}{2}}{n\pi}\cos(n\theta + \alpha_n) + \dots.$$

This latter expression gives the mean value of $f(\theta)$ through an interval $\pi/2$ on either side of θ. From it, all terms involving even multiples of θ are eliminated, and the coefficients of all terms after the second are diminished to a greater extent than that of the second.

A definition of the unit earthquake having been adopted, the earthquakes of different districts are classified in half-monthly groups, the first half of February containing fourteen days, and of all the other months fifteen days; and the numbers so obtained are reduced to intervals of equal length (fifteen days). The numbers for the two halves of each month are added together. The mean of the numbers for the six months from November to April gives the six-monthly mean corresponding to the end of January. Six-monthly means are calculated in this way for the end of each month; each mean is divided by the average of all twelve, and the difference between each quotient and unity is multiplied by the augmenting factor 1·589, in order to obtain the correct value of the ratio $a_1 : a_0$. The curve obtained by plotting these reduced means thus gives special prominence to the annual period, by eliminating the semi-annual period and all those which are fractions of six months, and by diminishing the amplitudes of all other periods with respect to that of the annual period.

In investigating the semi-annual period, the numbers corresponding to the first halves of January and July are added together, and so on; the rest of the method being the same as for the annual period. The result gives special prominence to the semi-annual period by eliminating the annual period, and by eliminating or diminishing the amplitudes of all periods less than six months.

Seismic Periodicity in relation to Intensity.—This discussion is founded on: (1) lists compiled from Mallet's great catalogue, first, of shocks which were so slight as to be just perceptible, and, secondly, of those which were strong enough to damage buildings; (2) Prof. Milne's classification of the Japanese earthquakes of 1885 to 1889 according to the areas disturbed by them; and (3) different catalogues relating to the same district, it being obvious that two such catalogues for the same time can only differ by the omission or inclusion of slight shocks.

The following results are obtained:—(1) In both periods, the amplitude is greater for slight than for strong shocks; (2) there appear to be two classes of slight shocks with an annual period, the stronger having their maximum in winter, the weaker in summer; and (3) in the case of the semi-annual period, both strong and slight shocks, as a rule, have nearly the same maximum epochs.

Seismic Periodicity in relation to Geographical Position.—The number of records examined is 62, 45 belonging to the northern hemisphere, 14 to the southern, and 3 to equatorial countries.

1. *Annual Period.*—In every district, and in all but five records (which are obviously incomplete), there is a fairly well-marked annual period. As a rule, different records for the same district agree in giving the same, or nearly the same, maximun epoch. Excluding, however, those which disagree in this respect, we have left 34 records for the northern hemisphere, 9 for the southern, and 2 for equatorial countries. In the northern hemisphere, 4 records give the maximum in November, 16 in December, and 6 in January; in the southern hemisphere, 2 in April, 2 in May, 3 in July, and 2 in August; the end of the month being supposed in each case. As a rule, then, the maximum epoch occurs in winter in both hemispheres. The amplitude of the annual period ranges from 0·05 (New Zealand) to 0·67 (Sicily and Algeria), the average of 57 records being 0·33.

2. *Semi-Annual Period.*—Of the 62 records examined, only 3 fail to show a semi-annual period, the cause of the failure in these cases being no doubt the imperfection of the seismic record. In New Zealand and South-east Australia, the maximum epoch generally falls either in February or March and August or September; in North America, as a rule, in March or April and September or October. But for other regions it does not seem possible as yet to deduce any law. The amplitudes of the semi-annual period ranges from 0·06 (southern hemisphere) to 0·79 (Mexico), the average value being 0·24.

3. In fifteen cases, the amplitude of the semi-annual period exceeds that of the annual period. Eleven of these records include the following insular districts, which are among the most well-marked seismic regions in the world, namely, the Grecian Archipelago, Japan, the Malay Archipelago, New Zealand, and the West Indies. The average amplitude of the annual period in these eleven cases is 0·16, and that of the semi-annual period 0·24; *i.e.* the average amplitude of the annual period is just half that for all the districts examined, while in the case of the semi-annual period the average amplitudes are the same.

Origin of the Annual Period.—In this, the concluding, section

©1893 Nature Publishing Group

of the paper, an attempt is made to show that the annual change in barometric pressure may be the cause of the annual change in seismic frequency. It would be difficult to prove that such a connection exists, but reasons are given which seem to render it in some degree probable.

1. The most probable cause of the origin of the majority of non-volcanic earthquakes is the impulsive friction, due to slipping, of the two rock-surfaces of a fault. Now, whatever be the causes of seismic periodicity, it seems probable that they are merely auxiliary, and determine the epoch when an earthquake shall take place, rather than there shall be an earthquake at all. Prof. G. H. Darwin has shown that the vertical displacement of the earth's surface by parallel waves of barometric elevation and depression is not inconsiderable, and that it diminishes at first very slowly as the depth increases. Since the fault-slip which produces even a moderately strong shock must be very small, and since the work to be done in such a case is, not the compression of solid rock, but the slight depression of a fractured mass whose support is nearly, but not quite, withdrawn, the annual range of barometric pressure does not seem incompetent to produce the effects observed.

2. Comparisons between the dates of the maximum epochs of the seismic and barometric annual periods are made in 31 of the districts treated in this paper. The seismic maximum approximately coincides with the barometric maximum in 10 districts, and follows it by about one month in 9, and by about two months in 4, districts; the other cases generally admitting of some explanation.

3. In several insular seismic districts, and especially in Japan and New Zealand, the amplitude of the annual period is very small; and, if many of the earthquakes of these districts originate beneath the sea, this should be the case; for, in the course of a year, as the barometric pressure changes, the sea will have time to take up its equilibrium position, and thus the total pressure on the sea-bottom will be unaltered.

PARIS.

Academy of Sciences, July 31.—M. de Lacaze-Duthiers in the chair.—Note on the work of M. D. Colladon, by M. Sarrau. M. J. D. Colladon, who died at Geneva on June 30, at the age of 91, was the first to transmit power to a distance by compressed air, and to utilise this power in boring tunnels. His system, proposed in 1852, was adopted in the working of the Cenis and Gothard tunnels. His name is also widely known in connection with improvements in paddle-wheels, and his celebrated investigation of the velocity of sound in the Lake of Geneva, in connection with Sturm.—Petroleum beds near Pechelbronn (Lower Alsace); exceptionally high temperatures observed there, by M. Daubrée. About twelve years ago the flooding of one of the petroleum mines of Pechelbronn by a sudden outbreak of the mineral oil suggested a substitution of boring and pumping for the laborious subterranean process, with the result that the yield was increased more than seventy times. The tertiary beds, which have an inclination of 7 or 8 per 100, are rich in gas, and the force with which the jets are projected when struck is sufficient to drench the men and produce a disturbance resembling an earthquake. It is calculated that all the sources together produce at present 80,000 kgr. of petroleum per day, and it is probable that many jets, if bored wide enough, would be capable of yielding 50,000 kgr. per day each. Some of the sources show a remarkable rise of temperature with increasing depth, reaching 1° for 7m. in one boring. This rise, contrary to the usual experience, becomes more rapid as the depth inereases. M. Daubrée attributes both the occurrence of the oil and the extraordinary distribution of temperature to a particularly energetic internal activity, chemical or otherwise, of the globe at that point.—On the unequal resistance to drought exhibited by some largely cultivated plants, by M. P. P. Dehérain.—Observation of four simultaneous water-spouts at Antibes, by M. Naudin. These were observed on July 27, on the sea between Nice and Antibes. They were ranged very nearly in a straight line running east and west. The wind had suddenly veered from west to east and the water-spouts were produced at the junction of the two air-currents, and were observed to turn in a direction contrary to the hands of a watch. They lasted several minutes, gradually approaching the land, and broke on the hills near the shore.—Photography and physical observation of comet *b* 1893, made at the Juvisy Observatory, by M. F. Quénisset. A photograph was obtained by means of a Hermagis lens of 16 cm. aperture, the exposure being 40m., on July 19. The negative shows a double tail, one of them 1° long and pointing east, the other 30′ long and inclined towards the north.—An addition to the nomographic method recently described, allowing the introduction of another variable, by M. Maurice d'Ocagne.—On benzoylnicotine, by M. A. Étard.—On the fixation of iodine by starch, by M. G. Rouvier.—On the preparation of caproic and normal hexylic acids, by M. J. Tripier.—On gallate of mercury, a new antisyphilitic preparation, by MM. Brousse and Gay.—On virulent and epidemic cholera, by M. N. Gamaleia. The concentration of the nutrient medium, and the abundance of saline matter in the culture fluid gives rise to several slightly different variations of the cholera vibrio, which agree in being very much more virulent than the ordinary type. The author suspects an analogy between this fact and the observed dependance of the epidemic upon the conditions of desiccation of the soil and the level of subterranean waters.—On submarine photography, by M. Louis Boutan.—On the habits of *Blennius sphinx* and *Blennius montagui*, Fleming, by M. Fréderic Guitel.—On the cerebral nuclei of the myriapods, by M. Joannes Chatin.—Researches on the anatomy and development of the male genital apparatus of the orthopterous insects, by M. A. Peytoureau.—Anatomical characters of the stems of the Dioscoreæ, by M. C. Queva.—Development of the ground-nut, by M. A. Andouard.—On a trial of a screw for vertical propulsion, by M. Mallet. A Langlois air propeller of 2·5 m. diameter was attached to the car of a balloon of 800 m^3. capacity, and worked by the muscular power of the aeronauts. During one minute the balloon was raised 100 m., sinking again to its former level on stopping the propeller.

CONTENTS.

PAGE
The Protection of Woodlands 337
North American Butterflies. By W. F. Kirby . . . 338

Our Book Shelf:—

Howard: "Life with Trans-Siberian Savages" . . . 339
Gregory and Christie: "Advanced Physiography" . 339
"Proceedings of the Edinburgh Mathematical Society" 340

Letters to the Editor:—

The Publication of Scientific Papers.—J. Y. Buchanan, F.R.S.; E. Wyndham Hulme . . . 340
The General Motions of the Atmosphere.—W. L. Dallas . . . 341
Thunderbolt in Warwickshire.—L. Cumming . . . 342
The Suicide of Rattlesnakes.—Edward S. Holden . 342
New Conclusions.—Graham Officer; Lewis Balfour 342
The Thieving of Assyrian Antiquities 343
British Association Meeting in Nottingham. By Prof. Frank Clowes 344
Magneto-Optic Rotation. (*With Diagrams.*) By Prof. Andrew Gray 345
The Earthquake in Baluchistan. (*Illustrated.*) . . . 348
Science in the Magazines 349
Marié-Davy 351
Notes 351

Our Astronomical Column:—

Comet 1893 (Rordame-Quénisset) 355
Comet Finlay 1893 355
Total Solar Eclipses 355
The Observation of Auroræ 355
New Determination of the Constant of Universal Attraction 355
Himmel und Erde for August 355
Geographical Notes 356
The Institution of Mechanical Engineers 356
The Williams Collection of Minerals. By L. Fletcher, F.R.S. 357
Proposed New Telescope for Cambridge Observatory 358
University and Educational Intelligence 358
Scientific Serials 359
Societies and Academies 359

©1893 Nature Publishing Group